

A MODEL OF ENTERPRISE SYSTEMS CAPABILITIES

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Abstract

This study has developed a model of ES capabilities to analyse the extent and quality of the use of ES in organizational contexts. The model consists of six general ES capabilities that can be used and deployed by organizations: 1) transaction automation, 2) decision-making process support, 3) monitoring performance, 4) customer service, 5) coordination, and 6) process management automation. The model itself was initially formulated from concepts in IS and ES literature. Then, the model was applied, validated and tuned through an in-depth case study.

Keywords

Enterprise Systems, ES Capabilities, ES Use

INTRODUCTION

ES potential has been reported by a number of authors (Davenport 1998 and 2000; Markus and Tanis 2000). A set of examples can be identified from automation of business transactions, interdepartmental coordination, to more sophisticated uses such as applying operations research techniques into processes management (e.g. MRP). Although much evidence has been reported around these issues, it is scattered without connection. Then, there is a need of a framework that allows viewing all the ES potential in a single map. This article tackles this need by developing the ES capabilities model, which represents taxonomy of ES uses in an organizational context.

RESEARCH METHODOLOGY

The model itself was initially formulated from concepts in IS and ES literature (Zuboff 1988; Hirschhorn and Farduhar 1985; Doll and Torkzadeh 1998; Davenport 1998 and 2000). Later the model was applied, validated and tuned through an in-depth case study. The following lines describe how the author derived the model. The study of the pilot case in a ES diffusion research identified that there was a concern about the low level of use of the ES after installation. Interviewees considered that the ES was used only as a transactional tool, but neither as a means to support the decision-making process nor to support better coordination between different business areas. From this concern, the author investigated models of classification of IT uses from the IS literature. First, by applying the Zuboff's (1988) IT roles, the author began dividing the possible ES uses in twofold: automating and informing. Later, by applying the Hirschhorn and Farduhar's (1985) and Doll and Torkzadeh's (1998) classifications, the author subdivided the possible ES informing role in three-fold: decision-making support, work integration, and customer service. Hence, automating was defined as applying ES to automate business processes so that these processes can be performed with more continuity, uniformity and control; and informing was defined as using ES to generate information about the processes so that organizations can improve their decision-making processes (decision support), coordination between different business areas (work integration), and customer service to internal and external clients.

This initial scheme was applied, validated and tuned through an in-depth case study. Users from the site under study were asked to comment on the different areas of functionality within the initial framework, whether they were using these ES capabilities, whether they were part of normal activity, and whether they had evidence of increased organizational effectiveness and business performance. This exercise allowed the author to have more clarification of the ES capabilities. As a result, some reconsideration on the early framework was done. Two further capabilities were identified: monitoring performance and process management automation. Linking these two additional capabilities to the ES literature allowed the author to validate them with one of the Davenport's (2000) works.

Site Description: Coffee Company (CC)

Founded in 1958, CC is a nationally leading company in the processing and distribution of roasted and ground coffee in one of the South American countries. Since 1992 CC has been exporting green coffee to the USA and Europe. In 2001, it earned US\$45 million in revenues and employed 370 persons. Figure 1 describes CC's business model in outline. The factory is the company's modern processing plant where coffee is roasted, ground and packaged. CC has a number of procurement centres located in the most important coffee regions over the country. Here, farmers sell their products directly to CC and independent purchase agents purchase coffee for CC. In the domestic market, CC distributes its products with its own trucks to 12 regional warehouses throughout the country. The company sells its products to 43 independent intermediaries, which then reach more than 11,900 final retail destinations. CC has also a sales force of 35 persons, which is responsible for selling to more than 700 big retail destinations (e.g. big supermarkets and chains).

CC acquired an ES in 1997 by purchasing it from one of the top five vendors. This ES was installed between 1997 and 1999 (the first version of the system was available for use in 1999). Then, between 1999 and 2002, the organization was engaged in a diffusion and infusion process to support more organizational functions and business units.

The primary methods of data collection were semi-structured interviews and documentary review. Forty-one semi-structured interviews were conducted, each lasting an average of one and half hours. The interviews included people related to ES implementation in one way or another: upper-management, functional management (key users), end users, technical specialists, project team, members of the personal department, and consultants. A review of documents focused on memos, users manual, procedures, system manuals, and reports of earlier implementation phases.

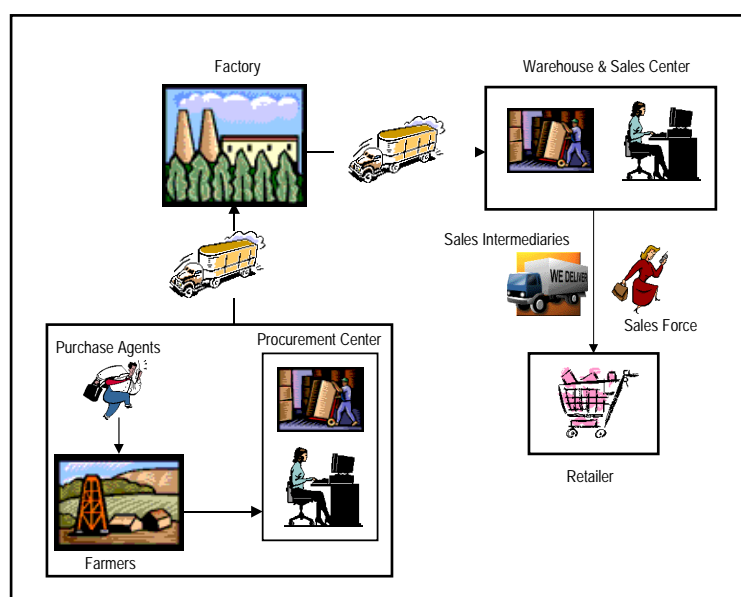


Figure 1 The CC's Logistic Processes

ES CAPABILITIES

By iterating and linking findings with literature, this study has developed a model of six general ES capabilities. The capabilities that can be used and exploited by an organization are as follows: 1) transaction automation, 2) decision-making process support, 3) monitoring performance, 4) customer service, 5) coordination, and 6) process management automation. As a multidimensional framework, this model has advantages in recognizing the organizational functions for which an ES is utilized, which originates better characterization of the extent of use (Doll and Torkzadeh 1998). The ES capabilities are explained in turn below.

Transaction Automation

This capability can be defined as utilising ES to automate business transactions in order to perform them with more uniformity and control (Zuboff 1989; Davenport 2000). Such capability includes processing data in an integrated and standardized manner, standardized flow of work, transaction control through business rules, and the possibility of tracking transactions and data. ES literature (Sasovova *et. al.* 2001; Markus *et. al.* 2000; Westerman and Cotteleer 1999; Davenport 1998; Worthen 2002; Benchmarking Partners 1997b) shows a number of cases where transaction automation is one of the first benefits of ES implementation:

- a) Standardizing transactions by using ES made Union Carbide more efficient (Davenport 1998).
- b) Dow Chemical achieved more consistent operating practices across their geographically dispersed units by using ES (Davenport 1998).
- c) Under the premise of “One Nestle under SAP”, Nestle transformed the separate brands into one integrated company. For example, the project team implemented a common data structure across the company – e.g. ‘vanilla’ was coded as 1234 in every division (Worthen 2002).
- d) The implementation of an ES allowed Tektronix to handle a worldwide chart of accounts and a single item-master table (Westerman and Cotteleer 1999).
- e) Monsanto achieved an exceptional degree of “commonality” across a diverse set of global businesses. For instance, by using ES the company reduced the coding scheme for suppliers from twenty-four to just one (Davenport 1998).
- f) ES provided Hoechst Marion Roussel better control of its finished-goods inventory and allow it to save transportation costs. The company can now know when the order was placed, when it was packed, how it was shipped, and when it arrived (Benchmarking Partners 1997b).
- g) Owens Corning can track daily finished-goods inventory both in warehouses and the distribution channels (Davenport 1998).

Decision-Making Process Support

This capability is concerned with business decision-making based on data provided by ES. Many authors have reported that the standard ES functionality is deficient

in fulfilling this organizational need (Brehm *et. al.* 2000; Markus *et. al.* 2000, Davenport 2000). Although ES are typically transaction processing systems, they may be augmented during further development of the ES (Bashein and Markus 2000; Brehm *et. al.* 2000). In fact, a common ES tailoring type realized by companies is programming extended data outputs and reporting options (see Brehm *et. al.* 2000). For instance, Microsoft Corp developed custom reports using the ES data, and delivered by using the intranet (Bashein *et. al.* 1997). In addition to these examples, ES vendors have recently developed enhanced functionality that provides decision-support tools such as query, reporting, statistical analysis capabilities, and multidimensional analysis (Davenport 2000; SAP 2002).

Monitoring Performance

This capability is concerned with the recording and monitoring of performance indicators. Typically this is achieved through management information tools, which give direct access to key performance measures of a company. For instance, the Baan IV product allows users to see an overview of the overall business performance by using Ishikawa fishbone diagrams (Jendry 2000). Managers can 'drill down' to the indicators and bring information from an integrated data repository. A set of predefined performance indicators is available, with the additional capability of developing custom indicators. SAP suite (SAP 2002) also offers tools to help managers to visually represent objectives, to monitor progress toward goals, and to monitor the performance of key indicators. Furthermore, in the near future ES providers will be able to link their current performance systems with common management framework such as Balanced Scorecard (Davenport 2000).

Coordination

This capability is a perennial topic in studies of the organizational impact of information technology (Crowston 2001; Malone and Crowston 1994; Rockart and Short 1989; Abarca and González 2000; Hirschhorn and Farduhar 1985). This framework relies upon Malone and Crowston's (1994) definition of coordination as "managing dependencies". That is, coordination is seen as a response to troubles caused by dependencies. Typical dependencies that may be handled by ES are those defined by Crowston (2001) as "share resource" and "producer-consumer". In the ES context, *share resource* can be seen as sharing the same body of information between different departments or business units that require it simultaneously. *Producer-consumer* is concerned with synchronizing activities or processes embedded in a value chain so that the resource required by the consumer is available when needed.

The ES coordination capability can be seen clearly in the Elf Atochen case (Benchmarking Partners 1997a; Davenport 1998). For instance, when *sharing* information, the sales forecast and production plan can be viewed online and simultaneously by everyone in need of this information (e.g. account managers, customer service, and manufacturing). The result of this is that inquiries from Customer Service to Manufacturing about finished products were eliminated. In relation to the *producer-consumer* dependency, the ES allowed the company to link the ordering and production systems. As orders were entered, the system

automatically updated forecasts and production plans, which enabled the company to quickly change its production runs in response to customer needs (i.e. synchronizing activities or processes in the internal value-chain). As Diaz (2000) argues, ES involve a conversion of disconnected vertical silos or departments, into horizontally integrated and coordinated cross-functional processes.

Customer Service

This capability is concerned with using ES to provide differentiated and customized service to internal and external clients. This definition has been borrowed from the IS-use framework by Hirschhorn and Farduhar (1985). It relates to the general argument made by Porter and Millar (1985) that information technologies can affect a company's ability to differentiate itself by optimizing its processes to customers' needs. Christopher (1992) argues that an organization reaches differentiation when customers perceive that making a transaction with the company is more "profitable" than with others. For example, an ES may support easier and speedier ordering by customers. This is also the case of Elf Atochem. By linking the ordering and production systems (see coordination above), sales representatives began promising firm delivery dates, which translated into improved service levels. Achieving service advantage through using ES was a very well planned target by Elf Atochem in order to win customer orders (Benchmarking Partners 1997a; Davenport 1998).

Process Management Automation

While transaction automation refers to the processing of transactions in an automated way, process management automation is concerned with the automating of administrative processes. That is, the ability of ES to take action on data by incorporating business rules and the heuristic that business specialists previously used to manage the process manually (Davenport 2000). The sophistication of this capability has evolved over time. Sophisticated algorithms and operations research techniques have been lately embedded inside the ES. In some cases, this has been possible through the development of bolt-on applications by third-party vendors (Davenport 2000). MRP (Materials Requirements Planning) and DRP (Distribution Requirements Planning) are examples of management techniques supported by ES¹. The most sophisticated ES provide automated supply chain management (SCM). SAP has recently unveiled the Advanced Planner and Optimizer (APO) as its tool for the Supply Chain Management (see www.sap.com).

¹ MRP/DRP techniques have been developed as sophisticated, computerized planning tools that aim to make the necessary materials or inventory available when needed. The concept originated with materials requirements planning (MRP), an inventory control technique for determining dependent demand for manufacturing supply. Subsequently, manufacturing resource planning (MRP II) was developed with the objective of improving productivity through the detailed planning and control of production resources. MRP II is based on an integrated approach to the whole manufacturing process from orders through production planning and control techniques to the purchasing and supply of materials. Distribution Requirements Planning (DRP) is the application of MRP II techniques to the management of inventory and material flow – effective warehousing and transportation support. (Rushton A. *et. al.* 2001).

A remarkable example of the use of process management automation is described by one of the Stanford's teaching case, which shows the manufacturing process under SAP/R3 (Wang *et. al.* 1995). The case covers the processes from order generation until delivery and it describes how the ES take action on data to manage specific processes. For instance, the output of the MRP functionality drives the manufacturing and purchasing functions. Given that each product to be manufactured has a bill of materials (BOM), which list all components necessary to create a final product, the ES 'calculate' the gross requirements for every component according with the production plan. Whether the current inventory is not enough (i.e. gross requirement minus inventory is a positive number), the system uses an 'optimal lot sizing' (similar to the Economic Order Quantity (EOQ) technique) to determine the quantity to order or produce. For materials produced in house, the MRP functionality creates a planned order, which can be converted into a production order. For purchased parts, the system creates a purchase requisition, which can be converted into a purchase order by the procurement area.

ES CAPABILITIES IN COFFEE COMPANY

Transaction automation

The CC case reveals a number of examples of transaction automation. For example, sales transactions were automated, allowing CC to realize a number of benefits. These include the following:

- Processing sales orders following standard flows throughout the regional sales centres.
- Reflecting these orders in real time on other areas (e.g. finance and outbound logistics).
- Controlling order confirmation by checking parameters previously configured in the system (e.g. intermediaries credit policies).
- Tracking the status of any order at a specific time.

The benefits were obvious. As the Chief Financial Officer pointed out:

"The ES has allowed us to standardize our processes. Before implementing the ES each remote regional warehouse and sales office could perform its activities according to the premise of its own manager. Now we do not deliver a sales order if the intermediary has accounts receivable expired of more than 30 days. This control was impossible in the past. Now we can safely sell on credit."

Similar examples occurred in all transactions automated by the ES in the finance, procurement, manufacturing, distribution and information technology areas. It is worth noting the information technology case. By implementing the service functionality the IT department automated the entering and recording of service orders from end-users (e.g. printer requires fix or adding fields to a specific report in the ES). These related to both the ES outsourcing and the CC's IT department. The benefits were pointed out by the IT manager as follows:

"The automation of the entering and recording of service orders allowed us to have a standard communication mean with end-users, which translated into better control and tracking of each transaction; ...each order is sorted by the ES according with a priority and complexity scheme, then each is assigned to a

specific technician; ...end-users can view the status of their orders by checking them in the system”.

Decision-making process support

Support for decision-making proved to be a complex issue for CC. They held the view that the success of the ES project would depend on it being able to provide them with high quality and prompt information. Yet, they felt that the standard version of its ES was unsatisfactory for reporting information. Hence, they demanded the development of the ES functionality to provide better reports. For example, thirty reporting options were developed to meet the finance department's requirements during the second and third years after installation. When these were accomplished, they then reported the extensive and routine use of the ES for decision-making support.

Monitoring Performance

The original plan of CC was to install and use the full performance monitoring facilities of the ES in years four or five. Before then, they found it useful to develop and utilize some performance monitoring functionality in support of their own balanced scorecard approach. As the IT manager pointed out:

“We would think of implementing the ES's management information tool when all transactional priorities were solved. In the meantime, the organization designed its own balanced score card and monitored its key measures through designing specific reports.”

As result of this, use of the monitoring performance capability evolved from a) designing specific reports inside the ES, to b) extracting data from the ES and handling it with Excel, to c) using the ES management information tool. For instance, in 2000 CC developed a report inside the ES in order to monitor the performance of the manufacturing costs (e.g. comparing the costs of planned batch vs. real batch). Either by designing specific report end-users were able to monitor the performance of the IT service providers vs. standard performance measures. In 2002, the IT department programmed a dynamic application using Excel and Visual Basic and interfacing it to the ES for monitoring the weekly company's sales budget. Finally, the company would implement the ES's management information tool at the end of 2002.

An interesting anecdote was told by the CEO about monitoring the weekly company's sales budget. According to him, the first time he used this application he viewed that at midweek one of the regional sales centres was having poor sales performance. By projecting this performance into the end of the week he was able to see that the sales for that centre would be less than the sales already budgeted for that week. Then he rang the manager of that centre to check why it could be happening. The manager's first words were “boss, how do you know it?” According to the CEO, after this application they began managing in real time.

Coordination

A number of coordination issues were addressed by the ES project. For example, there were a number of dependencies between accounting and procurement functions that motivated additional effort to share information. Procurement staff had to call external accounting colleagues, or wait to receive a report from external accounting, to know the status of the CC's accounts payable with its providers. The ES served as a coordination mechanism by allowing users from these areas to share the same information.

A further example of the coordination functionality of the ES comes with the finished-goods warehouse located in the factory. After implementing the ES in all regional warehouses over the country, the finished-goods warehouse was able to receive information on warehouses' inventory levels in real time. This information allowed them to send to these warehouses more accurate and prompt replenishment orders. As a consequence, they eliminated inefficient practices such as accumulating buffer inventory stocks in the regional warehouses – which is commonly used as mechanism to de-couple processes in a supply chain instead of synchronizing (Diaz 2000). Hence, the ES had a dramatic impact on the coordination between regional warehouses and the finished-goods warehouse. In addition, the logistics manager pointed out that by integrating the manufacturing, distribution and warehousing areas they expected to reduce the inventory levels from seven days to three days throughout the company over 2002.

Customer service

A number of customer service initiatives were introduced. Some of the earlier ones related to the use of ES functionality to allow end-users (internal clients) to enter service orders for IT. The value of the ES, beyond processing a transaction, is that it allows supporting easier and speedier ordering by end-users. This obviously increased the internal customer service levels provided by the IT department.

Other functions of the business provide further evidence of how customer service interactions have changed as a result of the ES implementation. One example provides a clear illustration of benefit. Prior to the introduction of the new system, intermediaries needed an average of four-hours (half-day) to acquire and load products onto their trucks in CC's sales transactions. After the process improvements took effect, the intermediaries only needed thirty minutes for the same sales transaction. This meant that they could pick products up twice a week instead of once a week. This reduced the intermediaries' average inventory by half and allowed them to use a vehicle of smaller capacity (reducing the cost of carrying inventory). These customer service improvements were widely appreciated by intermediaries.

In the near future, CC had planned to implement the Business-to-Business (B2B) functionality for the sales process applied to big clients. Big supermarkets and chains would be able to send electronic sales orders to CC. By doing this, clients may order easier and speedier than ever. That would be translated into higher customer service level provided by CC, which is likely to allow the company to differentiate itself from competitors.

Process management automation

Once the ES was implemented in the regional warehouses and the finished-goods warehouse, CC began the use of the DRP technique. DRP is an integral part of the ES's inventory management system. This allows planning the flow of goods between warehouses within one company. The roll-up of dependent demand from local warehouses to a central warehouse is governed by supply constraints and warehouse relationships. Recommended replenishment orders are generated automatically for the fulfilment of demand. These orders are effected after approval and release. The use of this ES capability requires a functional expert user able to understand and apply sophisticated management techniques over the organization.

FURTHER RESEARCH

This article is part of a research agenda on ES diffusion and infusion. The ES capabilities model will be re-applied in further sites in order to validate and tune the model. By using the framework of ES capabilities described above, evidence will be collected about the effective use of the ES. The aim is to develop a model of ES infusion. The levels of ES infusion at a particular moment of the ES experience will be projected by considering two dimensions: 1) the number of ES capabilities incorporated and 2) the number of business areas, units or processes that has been affected by each ES capability.

CONCLUSIONS

This study has developed a model of ES capabilities to analyse the extent and quality of the use of ES in organizational contexts. These capabilities are defined as those provided by ES to perform and support certain organizationally relevant functions. The model itself was initially formulated from concepts in IS and ES literature. Then, the model was applied, validated and tuned through an in-depth case study. The model consists of six general ES capabilities that can be used and deployed by organizations: 1) transaction automation, 2) decision-making process support, 3) monitoring performance, 4) customer service, 5) coordination, and 6) process management automation (see Table 1 for a brief description). The use of a multidimensional framework has allowed recognizing the organizational functions for which ES are utilized and has allowed better characterisation of the extent and quality of the ES use.

Table 1 The ES Capabilities Model

ES Capability	Definition
Transaction Automation	This capability can be defined as utilising ES to automate business transactions in order to perform them with more uniformity and control. Such capability includes processing data in an integrated and standardized manner, standardized flow of work, transaction control through business rules, and the possibility of tracking transactions and data.
Decision-making Process Support	This capability is concerned with business decision-making based on data provided by ES.
Monitoring Performance	This capability is concerned with the recording and monitoring of performance indicators. Typically this is achieved through management information tools, which give direct access to key performance measures of a company.
Coordination	Coordination is seen as a response to troubles caused by dependencies. Typical dependencies that may be handled by ES are those defined as “share resource” and “producer-consumer”. In the ES context, <i>share resource</i> can be seen as sharing the same body of information between different departments or business units that require it simultaneously. <i>Producer-consumer</i> is concerned with synchronizing activities or processes embedded in a value chain so that the resource required by the consumer is available when needed.
Customer Service	This capability is concerned with using ES to provide differentiated and customized service to internal and external clients.
Process Management Automation	This capability is concerned with the automating of administrative processes. That is, the ability of ES to take action on data by incorporating business rules and the heuristic that business specialists previously used to manage the process manually.

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